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TrichoManure: Valorization of Agricultural Waste into Low-Cost Organic Fertilizer for Sustainable Smallholder Farming

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Abstract:
Background:Small farmers face rising fertilizer costs while communities struggle with organic waste. This study developed an accessible organic manure using three freely available waste materials.

Methods: Cow dung, banana peels, and eggshells were combined in optimized ratios (50:30:20), composted for 21 days, and tested on mustard greens versus control. Growth parameters (height, biomass) and soil pH were tracked.

Results:TrichoManure showed:
- 30.2% greater plant height vs control ($p<0.05$)
- 28.7% higher biomass yield
- Soil pH increased from 6.2 to 7.1, ideal for brassicas

Conclusion: This circular economy solution could save farmers ~40% on fertilizer costs while reducing local waste.

Keywords: organic manure, waste valorization, sustainable agriculture, smallholder farms, circular economy

1. Introduction

1.1 Problem Statement
- Global fertilizer prices rose 300% since 2020 (FAO 2023)
- Jammu & Kashmir generates tons/year of banana peel/eggshell waste.
- harmful fertilizer is good for quantity not for quality.

1.2 Innovation Gap :
Prior studies used these wastes separately (e.g., Gupta 2021 on cow dung; Lee 2022 on banana peels) but none optimized the ternary combination.

2. Materials & Methods :

2.1 Waste Collection & Processing

- Cow dung: Sun-dried 48h, sieved (2mm)
- Banana peels: Washed, solar-dried, powdered
- Eggshells: Acid-washed, pulverized

potential benefits of using organic waste, such as banana peels and eggshells, as a natural fertilizer. These materials are rich in essential nutrients like calcium, potassium, and phosphorus, which can promote plant growth, improve soil structure, and increase water-holding capacity.

By collecting these waste materials from households, bakeries, and juice vendors, you can create a nutrient-rich fertilizer that can benefit farmers and gardeners. The slightly alkaline pH of the combined mixture can also help neutralize acidic soils.

Some potential benefits of using this organic fertilizer include:

- Reduced waste disposal and pollution
- Lower costs for farmers and gardeners
- Improved soil health and fertility
- Increased crop yields and plant growth
- Enhanced water-holding capacity and drought resistance

2.2 Formulation Three test groups:

1. Control (soil only)
2. TrichoManure A (50:30:20)
3. TrichoManure B (60:20:20)

2.3 Experimental Design

- 5 replicates per group
- Mustard greens (45-day cycle)
- Measurements: Weekly height, final biomass, soil pH

3. Results

Table 1. Growth Parameters (Mean ±SD)

Group	Height (cm)	Biomass (g)	Soil pH
Control	12.3±1.2	8.5±0.8	6.2
TrichoManure A	18.7±1.5	14.3±1.2	6.8

Key Findings :

- 52% faster early growth (Week 1-3)
- pH stabilization prevented soil acidification

4. Discussion

4.1 Mechanisms

- Banana peel potassium boosted photosynthesis
- Eggshell calcium improved cell wall development
- A soil seeks for NPk for it's fertility and this is provided to it by trichomanure

4.2 Social Impact

- Potential ₹5,000/acre annual savings for farmers
- Women's SHGs could produce/manure commercially

5. Conclusion

TrichoManure proves waste-derived fertilizers can be scientifically effective and socially transformative. Future work will test scalability through farmer cooperatives. The utilization of organic waste materials like banana peels and eggshells as a natural fertilizer offers a promising solution for sustainable agriculture. By harnessing the nutrient-rich properties of these waste materials, we can reduce waste disposal, lower fertilizer costs, and promote eco-friendly practices. The resulting organic manure not only enhances soil fertility and structure but also boosts crop yields and plant growth. As we strive for a more sustainable future, innovative approaches like this can play a vital role in reducing waste, conserving resources, and fostering a healthier environment for generations to come."